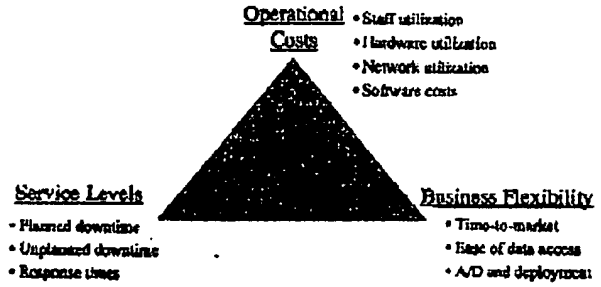
The ITcentrix Value Contribution Model

What is it and How Does it Work?

The ITcentrix Value Contribution Model (Figure 1) provides a strategic framework to assess IT's contribution to business value. It is based on a proprietary and tested methodology that combines cost, technology and business modeling to more accurately predict how changes in IT will impact business results. The data from the model are calibrated using real world case studies of Global 2000 corporations and other public and private sector institutions.

Figure 1

The ITcentrix Value Contribution Model



The model bases assumptions on actual customer data and allows users to make changes to reflect specific applications and IT elements (e.g. application value, levels of availability, planned downtime, network utilization, etc.).

Three high-level ***Business Value Contributors*** are quantified and analyzed to assess the value contribution of a particular technology approach:

- ***Operational Costs*** – [Metric: Cost Savings] - Emphasizing factors such as staff efficiencies, hardware utilization and network costs.
- ***Availability*** – [Metric: Incremental Revenue or Productivity Dollars] - Emphasizing application availability and costs associated with planned and unplanned downtime.
- ***Flexibility*** – [Metric: Incremental Revenue or Productivity Dollars] - Emphasizing the time to develop and introduce new applications (i.e. time-to-market) and the value generated from faster deployment times.

Each of these high-level value contributors contains numerous sub-elements and data points solicited from actual customer situations. These factors are assessed to develop an accurate view of current technology approaches (***The Base Case***) and compared to alternatives. The explicit intent of the model is to allow customers to compare tradeoffs of changes to the Base Case in business value terms. [All components of the model are quantified in value terms and represent real dollars - e.g. cost savings, revenue potential and/or productivity gains].

New World IT – Enabling e-business Value

Introduction

As an IT professional, what percent of your time is spent on issues that are internal to your organization versus external or customer-focused? Is there any doubt that over the next ten years the latter will predominate?

In the forty-plus year history of the IT business, companies have spent billions of dollars building IT infrastructures aimed at improving internal operations. In the past ten years alone, companies have enforced PC hardware and software standards, built internal network infrastructures, created help desk capabilities, made extensive use of advanced packaged software and developed credible application groups. Just when [illegible] – The Internet changed the rules.

Once viewed as state-of-the-art, client/server infrastructures are insufficient to meet the demands of today's businesses. To respond, companies must completely revolutionize their management approach and shift the emphasis of IT from one of an internally managed asset to a revenue-producing engine.

IT organizations face enormous pressure to create new transaction systems that integrate with legacy information to enable online buying, best-in-class customer service and seamless partner connections. And it has to be done quickly as time-to-market has become the most important competitive advantage.

A New World Nightmare

Consider the following real-world example of how a successful, established company has to completely re-engineer its strategy around IT.

For years, a major European publishing firm has enjoyed enormous success. Its properties were viewed as leading edge among consumers and business professionals alike. Its editors and writers were some of the most respected in the industry. Growth rates consistently exceeded 25% per annum and profitability, while sometimes under pressure during tough economic times, always rebounded to higher levels.

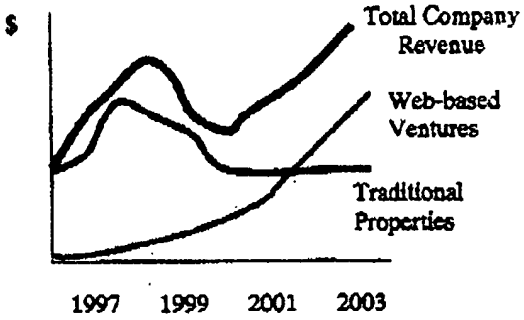
The company's board was conservative and steadfastly resisted the temptation to incur debt. It grew organically, the old fashion way. It also avoided turning to equity markets for funding. It preferred to maintain a private company atmosphere and use this to its advantage. The multibillion-dollar company had grown to over 4,000 employees worldwide and was on a roll.

Suddenly everything changed. Circulation for the major properties began to stall and advertising revenues flattened. As in rough economic times before, the company turns to drastic cost-cutting measures. The problem however, this time the economy is booming.

Webzines are popping up everywhere and sniping at the company's core franchise. These upstart competitors are able to launch new, Web-based publications, staff up with 50-60 writers and achieve huge circulation for one-third the cost. What's even more frustrating is that these companies are well-funded, growing rapidly, publicly traded and command enormous valuations. Even after the market corrects, and these new firms are trading at 30% of their all time highs, their valuations are 20-30 times revenues (versus 1X for traditional publishers).

Almost overnight, everything has changed. The company's revenue forecast resembles the following chart.

Figure 1: The Impact of the Web



Perhaps the picture doesn't look so bad. The company is telling its employees to hang in there, it is very well positioned. They have the advantage (despite what the market thinks). They have real profits and once the market reaches equilibrium everything will swing back in their favor. What's more, they can use their print publications to increase eyeballs on the Web. In theory, it sounds great.

Maybe so, but the market doesn't value paper anymore. The company is perceived as a "dead-tree" maker with a questionable future. The best employees are leaving and the company has lost all its momentum. Its community of readers is defecting to other Web-sites and the advertisers have begun to question the viability of many of the company's properties. Potential partners are looking elsewhere and a once long line of potential acquirers is refocusing targets and overpaying for pure play Web publishers.

The board looks to the outside world as if it's in a coma. It is torn between hanging on to the traditional print franchise and shifting the company's focus toward the Web. It doesn't want to lose what it took twenty years to build and at the same time it is losing altitude rapidly.

The problem and the solution are underscored by the company's IT strategy. Information technology has been a cost item at the firm, pushed out to the business units and focused almost solely on financial operations and internal productivity. Compared to its Web-based competitors, which are basically Web sites with home-based writers who have access to a Web browser, the company's infrastructure is too decentralized, too expensive and not focused on the right opportunities.

This scene is playing itself out across the globe and in case studies at business schools. Every company knows it has to change its IT strategy but all too often there's more talk than action. This position paper provides a starting point and call-to-action toward the development of a New World IT infrastructure that emphasizes e-business value. It presents the ten steps that need to be considered when transforming an existing infrastructure into a customer-facing IT approach. Importantly, the paper provides methodologies for quantifying the business value of IT that can be applied in strategic and tactical planning.

The goal of the paper is to help companies improve their time-to-market strategies with IT. While recognizing the need for operational excellence, the paper is advocates using information technologies and infrastructures to accelerate application development and deployment and generate tangible business value.

Building the New World Data Center – Ten Practical Steps

A major challenge facing companies today is how to leverage existing IT assets and re-orient them toward the customer to increase revenues, improve customer service and accelerate time-to-market. The task is complicated by several factors including Y2K fixes, staff shortages and inflexible IT infrastructures. Indeed, with the long list of technology distractions facing businesses today, combined with severe staff shortages, it's not surprising to see companies emphasize operational effectiveness and lower costs ahead of time-to-market.

To address these issues and better respond to customer demand, companies are developing what we refer to as The New World Data Center. The New World Data Center is a network-centric information center that puts the external customer first in the priority line. The New World Data Center centrally manages both internally and externally connected resources using the acceptance of IP as a catalyst for common communications across IT boundaries.

The New World Data Center is a competitive imperative. The options afforded by the New World Data Center dramatically improve the ability of IT Management to adapt to rapidly changing business environments and accelerate time-to-market.

ITcentrix has developed the following ten guidelines and corresponding self-probing questions toward developing New World IT; they include:

1. ***Know thy Business Model*** – (Do you understand why your company is or is not successful?)
2. ***Set Winning Goals*** – (When you value IT are you focused on the right attributes?)
3. ***Measure Honestly and Measure Often*** – (How do you measure value?)
4. ***Prioritize and Plan for Success*** – (Do you understand the business value of the applications being deployed at your company?)
5. ***Develop High-Impact Applications*** – (Are the applications your company is developing high impact?)

6. ***Design External Applications for Continuous Business*** – (Are your Web-based applications designed for continuous access?)
7. ***Manage Assets and Resources Proactively*** (Are you getting the most out of your hardware/software and people assets?)
8. ***Partner Sensibly and Simply*** – (Are you making the right choices?)
9. ***Rethink Make V. Buy Strategies*** – (Is outsourcing in your future?)
10. ***Design Flexibility into IT Infrastructures*** – (Can your IT infrastructure accommodate rapid and frequent change?)

What follows is a brief discussion of each issue with tips and tools to getting started.

Know thy Business Model

Business alignment has been the "war cry" of IT managements for years. Y2K notwithstanding, it is common for IT strategies to be "rear view mirror" oriented, responding to past business pressures and not proactively addressing current corporate objectives. It is not uncommon for executives to have unclear or diverging opinions of corporate strategy so chances are that IT professionals will often not have the most current view of the underlying business model of a company, especially when it is transitioning rapidly.

Consider the following points to aid in IT/business alignment:

- Understand your business model and how it will evolve.
- Research the competition and emerging business models.
- Know the end customers and evaluate their IT needs.
- Get plugged in to the corporate planning process.
- Participate in strategic decision-making.
- Tie incentives to supporting business objectives.
- Involve business management in setting IT priorities.

Take the following Business Model test: Business *and* IT professionals should be able to easily answer the following ten questions in less than two minutes:

1. What business are we in?
2. What do we sell?
3. Who are our customers?
4. How many customers do we have?
5. Who sells our products/services?
6. Customers buy our products/services because...
7. What is our main differentiator?
8. How (or when) do we make money?
9. Lower costs, better service or getting to market fastest which **one** is most important to our company and why?
10. What are our major constraints to growth and increased success?

Difficult IT tradeoffs are often made without the input of business management. The reverse situation is also common and IT professionals must be proactive about injecting themselves into the business planning and decision-making process. Being able to answer these simply questions quickly is a starting point.

Set Winning Goals

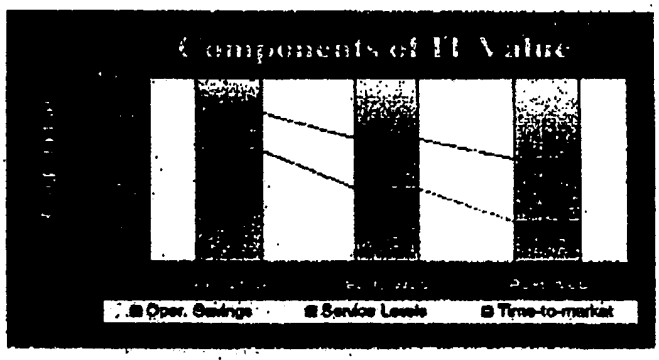
If you plan for mediocrity, chances are you'll succeed. Implementing the New World Data Center philosophy starts with a set of objectives that best meet an organization's overall direction. If corporate objectives are to attain a leadership position, then IT must, by definition, achieve best-in-class status. Some considerations include:

- Begin IT planning with external customer needs.
- Serve an order of magnitude increase in the number of connected clients.
- Accommodate extremely high and previously unforeseen levels of availability.
- Agree (with lines of business) on service level targets two years out—Aim high.
- Rapidly reduce cycle times for supporting new business initiatives.
- Increase IT's contribution to business success.
- Support Post-Web economics and new business models.
- Assign cross-functional teams to implement goals.

Importantly, specific targets need to be placed on each (or most) of these items so that measurements and incentives can be implemented.

What's missing from this list is anything to do with costs. Competitive operational costs are the ante in today's business environment and while companies should strive to simplify IT, it is only part of the equation.

Consider the following chart:



Based on extensive case studies with dozens of Global 2000 corporations and the application of extensive value analysis, ITcentrix research shows that the value contribution of IT is changing dramatically. Once derived primarily from operational

cost reductions, IT value increasingly is trending toward improvements in customer service levels and time-to-market improvements.

As the case study used at the beginning of this paper demonstrates, time-to-market improvements and customer service levels can make or break businesses. What would it have meant, for example, if Barnes and Noble were able to launch its Web site nine months earlier? What would it mean to your company if your Web-based business forecasts could be shifted to the left by several months?

Measure Honestly and Measure Often

Without measurements, there is no sound basis for further investment. IT should be approached in a fashion similar to any business initiative and open and honest measurements are compulsory. Chances are you will not get it right the first time so frequent measurements and adjustments will be necessary. The following points can serve as guidelines:

- Develop ways to measure the total value contribution of IT.
- Measure factors such as service levels and availability at the customer level. (What the customer doesn't see, doesn't exist).
- Measure customer satisfaction often and honestly (e.g. number of customer incidents as opposed to complaints).
- Benchmark against the leaders, not the average of all competitors.
- Benchmark leading companies outside of your industry but with similar economic models.

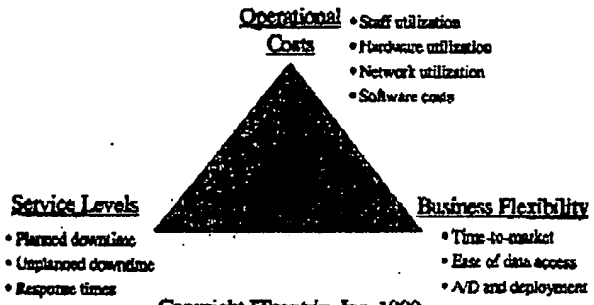
To adapt to these changes, companies are re-thinking the way they measure the value contribution of IT in order to evaluate outward-facing investments. IT has historically been measured in terms of cost savings and value contributors like service levels and time-to-market impacts have been relegated to the back burner.

The ITcentrix Value Contribution Model (see Figure) provides a strategic framework to assess IT's contribution in business value terms and specifically reflects the value of customer-facing IT. It is based on a proprietary and tested methodology that combines cost, technology and business modeling to more accurately predict how changes in IT will impact business results. The data from the model are calibrated using real world case studies of Global 2000 corporations and other public and private sector institutions from the following segments:

- Financial services
- Insurance companies
- Transportation companies
- Health care providers
- Large equipment manufacturers
- Pharmaceutical companies
- Telcos
- Retailers

- Distributors
- Internet Service Providers
- Consumer and industry-oriented Internet startups
- Government and educational institutions

The ITcentrix Value Contribution Model



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The model uses assumptions based on actual customer data and allows users to make changes to reflect specific applications and environments (e.g. application value, levels of availability, planned downtime, network utilization, workloads, etc).

Three high-level ***Business Value Contributors*** are quantified and analyzed to assess the value contribution of a particular technology approach:

- ***Operational Costs*** – [Metric: Cost Savings] - Emphasizing factors such as staff efficiencies, hardware utilization and network costs.
- ***Service Levels*** – [Metric: Incremental Revenue or Productivity Dollars] - Emphasizing application availability and performance and associated costs.
- ***Flexibility*** – [Metric: Incremental Revenue or Productivity Dollars] - Emphasizing the time to develop and introduce new applications (i.e. time-to-market) and the value generated from faster deployment times.

Each of these high-level value contributors contains numerous sub-elements and data points solicited from actual customer situations. These factors are assessed to develop an accurate view of current technology approaches (***The Base Case***) and compared to alternatives. The explicit intent of the model is to allow customers to compare tradeoffs of changes to the Base Case in business value terms. [All components of the model are quantified in value terms and represent real dollars - e.g. cost savings, revenue potential and/or productivity gains].

By analyzing changes to IT, we are able to more clearly understand the components of value. The model allows certain values to be

held constant (e.g. application response times) so that other factors can be assessed in a more in depth manner. This allows IT professionals to run "what ifs" and quantify tradeoffs (e.g. cost versus availability).

In today's fast-paced environment, an IT organization that develops a methodology around such a tool can help communicate IT imperatives in business terms. This in and of itself has value in terms of making more rapid decisions. More importantly, however, such an approach can bridge the gap so often seen between aggressive line of business professionals, with enormous time-to-market and competitive pressures, and the IT staff chartered with implementing leading edge solutions.

Prioritize and Plan for Success

Having established winning IT goals at a broad level and agreeing on the tools in the planning processes to measure the contribution of IT to the business, we now turn our attention to the priorities of the company. While well-understood planning principles involving the entire IT organization, with business input, are fundamental to this process. As always, buy-in and communication are the key ingredients.

What is different from typical planning processes, however is the business justification. Establishing clear and credible links to revenue generation, enlisting line-of-business advocates and communicating results in business terms are essential elements. We believe this process starts by evaluating the value of the applications being deployed and maintained.

What follows is a brief methodology to assess the value of the applications to the business. We start by asking ten basic questions about the applications (with a particular emphasis on strategic applications and those targeted for near-term development and deployment), including:

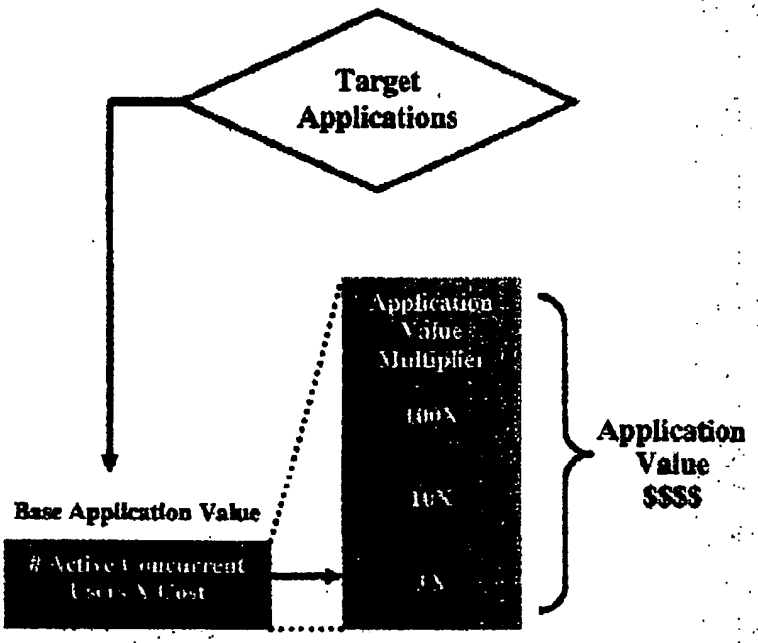
1. How can we best establish the value of our application portfolio?
2. Are the highest impact applications getting development and deployment priority?
3. How many users are/will be connected to these applications?
4. What percent of these users are/will be active and concurrent users on average?
5. What is the average cost of this user (fully loaded)?
6. What is the unplanned downtime (or expected unplanned downtime) for these applications in a given period of time (e.g. three months, one year, etc.).
7. How much business or productivity (as a percentage of the total) is/will be lost during unplanned downtime (assuming a typical length of application unavailability).
8. Is/will planned downtime causing lost business?
9. What percentage of overall company revenues are/will be comprised of these applications?
10. Is our IT infrastructure an inhibitor or enabler to application development and deployment?

Once these issues are explored, it is a fairly straightforward exercise to gain consensus on the value of the applications using the information collected. Importantly, the questions should be posed (at least in part) to both line of business professionals and customers impacted.

A simple methodology is to take the information developed above and begin to value the applications according to the following formula/process (see chart):

- Take the number of active/concurrent user for a specific application.
- Multiply this number by the fully loaded costs per active/concurrent user.
- The result establishes is the ***"Base Application Value."***
- "Uplift" the base application value by an ***"Application Value Multiplier"*** that reasonably reflects the total application value to the business.
- Check this figure as a percentage of overall company revenue.

Calculating Application Value



Keep in mind that the value of an application, will almost always be greater than 1X the Base Application Value (or what is the point of developing and deploying the application?). While there may sometimes be compliance or other extenuating circumstances, this rule of thumb should generally hold true.

Additionally, the Application Value Multiplier should vary dramatically by type of application. A financial application, for

example might only have a 2X or 3X multiplier whereas an e-commerce application should be significantly higher (10X or greater). A decision support application might only consist of a few active/concurrent users but because their decisions are so highly leveraged the multiplier might be as high as 100X.

Consider external users/customers in the equation where applicable and constantly compare the values as a percent of total company revenue for sanity checks.

Once established, this method can be used as a framework to prioritize application development and deployment priorities, assess the cost of downtime and measure the value of faster deployment and time-to-market improvements. It can also be used as a tool to assess how changes in IT infrastructure (which will impact costs, availability and time-to-market) add to business value.

Develop High-impact Applications

In July and August of this year, ITcentrix conducted a survey of 200 U.S. corporations running Unix and NT servers. We interviewed respondents in companies with over 5,000 employees across a wide range of industries. According to the survey, most corporations spend a vast majority of their resource maintaining and enhancing existing infrastructures. Despite the fanfare, frequently, a relatively small emphasis is placed on really high-leverage external, Web-based activities.

For respondents' Unix and/or NT platforms, we asked IT and Data Center Management Professionals to cite the single most important application running on their NT and/or Unix systems. The following table shows the results:

Most Important Unix and NT Applications

Most Important Application	*NT%*	*Unix%*
Email/Messaging	37	15
Decision Support	14	10
Financial/Accounting...	10	22
File & Print	10	7
Web/e-commerce Applications	6	8
Systems/NW Management	6	5
Application Development	3	5
Collaborative Apps	3	2
Technical/Scientific	2	10
ERP/ERM/Supply Chain	2	4
Personal Productivity	2	2
Other	5	10
N = 200 Respondents	100	100

While email and messaging were frequently cited in the survey, and these can often be considered external applications, it is noteworthy that pure Web-based and e-commerce applications were infrequently cited as the most important by these respondents.

While this is not exceedingly surprising, the data underscores the fact that most companies are merely in the early stages of Web-based development. This in and of itself presents a major challenge for established companies as they struggle to maintain existing infrastructures while at the same time capitalizing on Web-based opportunities (and defend against Web threats).

New World IT professionals should strive to spend 80% of their time on "the 10's," applications that produce significant e-business value. Importantly, this means optimizing applications for external value in addition to internal efficiency.

The importance of this effort cannot be overstated. History suggests that purely focused companies will have an impact on established players and cause meaningful discontinuities in the competitive structure of several markets. Despite talk of overvaluations, Internet bubbles and profitless enterprises, there is little doubt that today's Web-based entities are getting to market faster, adding significant value for customers and doing so with far less cost than most established firms. It would be unwise to bet against this trend wreaking major havoc on existing companies.

At the same time it is vital for established companies to maintain perspective. It is unrealistic to expect that 100% of the world's books will be sold online or that every stock trade will be handled over the Internet. In all likelihood, markets will eventually reach equilibrium phases and firms must strive to embrace change and accelerate their time-to-market.

The following points are worth considering when thinking about new applications:

- What companies do with IT is now more visible than ever.
- Expect orders of magnitude increases in customer volume, service requirements and change requests.
- Consider the business value of trading operational costs for better service levels and faster time to market and evaluate such a business case.
- Take advantage of bandwidth and community.
- Design for business continuity.

Design External Applications for Continuous Business

Companies are experiencing orders of magnitude increases in the number of connected customers and their corresponding application availability requirements. High availability and increasingly, disaster tolerance, once the domain of only a few select applications, is becoming more fundamental to business operations.

ITcentrix has developed a method for considering the business value of availability, and disaster tolerance. Typically viewed as an exceedingly expensive proposition, designing for business

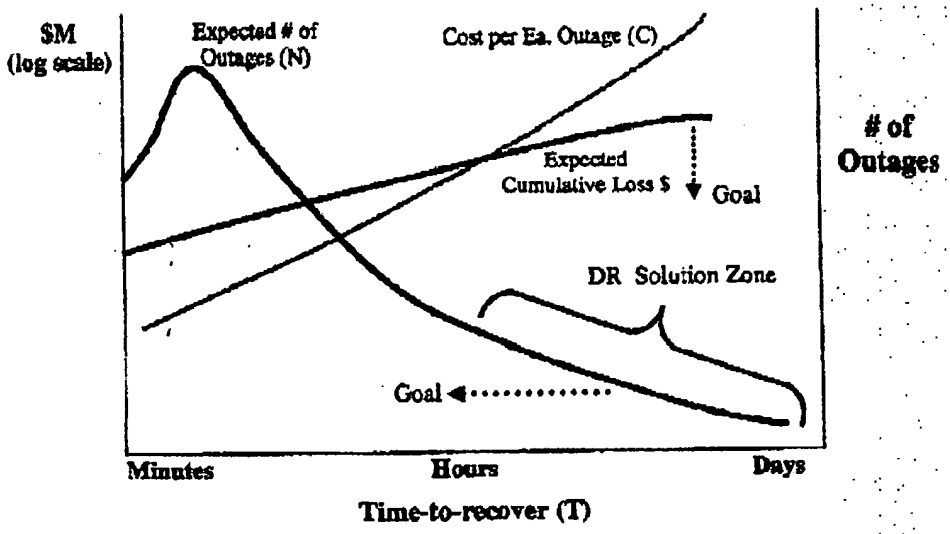
continuance and even disaster recovery (DR) is becoming necessary in many Web-based businesses.

The following section outlines a method and tools to conceptually evaluate a company's need for business continuance and apply techniques and measurements to assess its business value to a particular application. Notably, the approach builds upon concepts developed in previous sections of this paper.

Customer feedback indicates that considerations on business continuance justifications follow this general thinking:

1. In a given period of time (e.g. one year), outages will occur over a range of recovery times (minutes, hours, days, etc.)
2. Some N number of outages will occur within each recovery range based on a probability P.
3. The business impact (C = cost) of each outage (i.e. lost revenue/productivity/customers) increases as a function the magnitude of the failure (i.e. T = time-to-recover).
4. The degree of business impact (C, cost of downtime) *times* (T, time-to-recover) = Expected Lost Dollars [C X T = Expected Loss] for a given outage.
5. The cumulative loss to a business in a given year equals the sum of the costs of each outage over some N number of outages (see Figure).

Assessing the Value of Business Continuance



Simply stated, the business goal of a continuous application solution is ***a decrease in the time-to-recover at a much lower solution cost.*** As it relates to the above chart, the business

continuance value proposition is to shift the # of Outages curve to the left (i.e. faster recovery times) thereby reducing the Expected Cumulative Loss (per year).

A Business Continuance Value Model would therefore focus on three primary factors:

1. Costs including: Business impact of downtime (which increases as a function of the magnitude of the failure) and solution costs (Operational Costs)
2. The probability (P) of a failure (expected number of failures per year → N)
3. Time-to-recovery (T)

Each component of the model can be quantified in hard dollar terms to enable an expected loss calculation as a function of business impacts, expected failure rate and recovery times. Value is then calculated as follows:

Value of a Continuous Solution = Reduction in Loss

Manage Assets and Resources Proactively

Most companies have generally accepted approaches to hardware and software asset management. Not surprisingly, however, few have truly accurate views of staff productivity and consequent morale issues. Our research indicates that typically companies are unaware of between 30-60% of the hidden costs related to poor staff utilization.

This problem is especially acute in client/server environments where Unix and especially NT servers are springing up across the entire enterprise. Typically, unlike most mainframe installations, staff expertise is not aligned to a specialty area (e.g. network management or storage management). Rather frequently, a portion of a staff person's time is spent on each management task. This makes tracking staff time difficult and often results in poor hardware, software and network utilization.

Time in motion studies, proactive solicitation from employees on improvements needed, formal performance reviews and leading-edge training are common attributes of IT leaders. What is different in the New World Data Center is the increased emphasis on utilizing external services where appropriate. We believe companies need to develop longer-term plans with regard to the use of external services to incorporate them more aggressively as they mature.

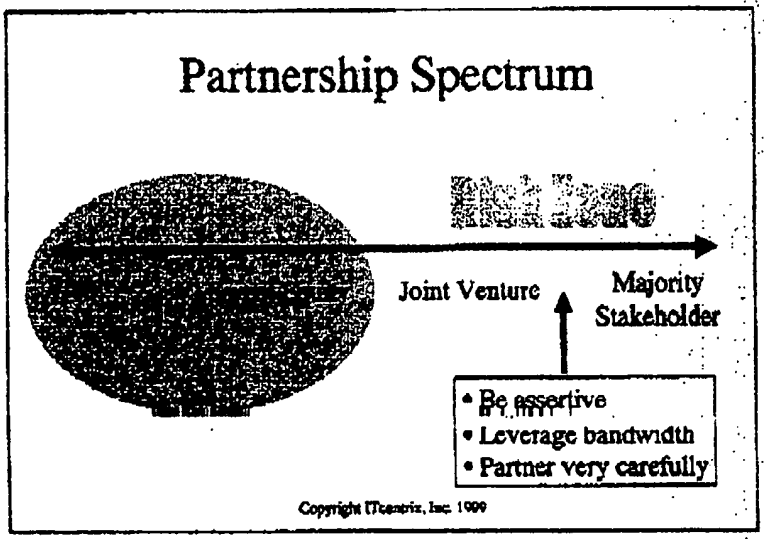
Partner Sensibly and Simply

Many companies' key partner lists are made up of suppliers and contain little substance. Rather we believe the emphasis of partnerships should be on adding complementary value to include factors such as:

- Increased coverage
- Improved customer value
- Knowledge transfer
- Improved market awareness
- Increased revenues

Importantly, complex partnership deals are doomed for failure and a strong emphasis should be placed on clear goals and results with a vision toward extending future value.

As it relates to New World IT, a primary focus should be on setting standards to improve interoperability and time-to-market. A range of partnership options should be considered from lower risk reference selling (exchanging ideas and leveraging customer contacts) to full blown joint ventures (see following figure)



This slide represents the spectrum of choices for a more full-scale market effort beyond simply being a passive provider of products or services. The "Risk Zone" is not intended to represent advice to avoid an initiative, simply to note that if companies decide such an approach is warranted we believe the points in the box describe critical success factors for today's Internet economy. They include:

- Aggressive entries into markets with high expectations and visible marketing

- Accessing, where possible, the spate of Internet-related funding that is available to those companies with Web potential
- Leverage huge investments in infrastructure that are underway by telecommunications and cable companies
- Be wise about selecting partners that have complementary businesses

Other partnership considerations include using direct sales and service organizations and potentially offering "freeware" in exchange for a piece of the revenue action from the partner/end service provider. Numerous scenarios could work including:

- Reference selling for a commission
- Trading product or service for a portion of the revenues
- Trading both of the above for equity in a company
- Commitments to buy a particular partner's solutions
- A combination of all of the above

Remember also, that while so-called freeware strategies are in vogue in the Internet economy, those products and services that lend themselves to near-infinite economies of scale (with volume) will likely prove the best candidates for trade.

Examples include software, certain services and leveraged device/service combinations (e.g. cell phones and cellular services). Products and services with less attractive marginal economics (e.g. free/cheap PC's and cheap/free Internet access) are less likely to produce the desired results as the profits will tend to go to one partner only (or neither).

Rethink Make V. Buy Strategies

"We outsource everything that can be reliably handled externally and is not of significant business benefit to our organization. This, in part, means we are moving from a programming-oriented operation to one that is more focused on integration and managing relationships that deliver value."

-CIO of a Major Financial Institution

Outsourcing is being driven by a number of trends that relate to the difficulty corporations have today in retaining staff and incredible pressures on rolling out new applications. Compounded by Y2K fix efforts, these issues make outsourcing a logical consideration. Lower network costs and thin computing models also contribute to the viability of the concept. Finally, the blending of network and software economics into a new services economy (i.e. the ability to provide mass customization at much lower costs) make new forms of outsourcing a potentially attractive business proposition for companies.

Outsourcing is taking new shape. Dominated by traditional services companies like EDS and CSC, outsourcing is seeing new,

- Accessing, where possible, the spate of Internet-related funding that is available to those companies with Web potential
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Remember also, that while so-called freeware strategies are in vogue in the Internet economy, those products and services that lend themselves to near-infinite economies of scale (with volume) will likely prove the best candidates for trade.

Examples include software, certain services and leveraged device/service combinations (e.g. cell phones and cellular services). Products and services with less attractive marginal economics (e.g. free/cheap PC's and cheap/free Internet access) are less likely to produce the desired results as the profits will tend to go to one partner only (or neither).

Rethink Make V. Buy Strategies

"We outsource everything that can be reliably handled externally and is not of significant business benefit to our organization. This, in part, means we are moving from a programming-oriented operation to one that is more focused on integration and managing relationships that deliver value."

-CIO of a Major Financial Institution

Outsourcing is being driven by a number of trends that relate to the difficulty corporations have today in retaining staff and incredible pressures on rolling out new applications. Compounded by Y2K fix efforts, these issues make outsourcing a logical consideration. Lower network costs and thin computing models also contribute to the viability of the concept. Finally, the blending of network and software economics into a new services economy (i.e. the ability to provide mass customization at much lower costs) make new forms of outsourcing a potentially attractive business proposition for companies.

Outsourcing is taking new shape. Dominated by traditional services companies like EDS and CSC, outsourcing is seeing new,

specialized players focused on applications "renting," infrastructure outsourcing for items such as storage and network capabilities to staff and employee outsourcing.

These trends underscore the economic attraction of customized services. In the Pre-Web era, computing economics became well-understood in the various IT segments. Specifically, hardware had some level of scale economies (e.g. cheaper component and better manufacturing efficiencies) while software afforded very attractive profitability (e.g. Microsoft). The incremental cost of software delivery went to nearly zero as volume increased. Services were almost opposite to software where the greater the scale (volume), the larger the expenditure required to meet demand (mostly staff costs).

In the Post-Web era, however, customization is possible in very high volume by combining networking economics (Metcalfe's Law – "the value of the network increases exponentially as the number of network connections increases") with software economies. Hence mass customization in a Web-based economy tends to take on software-like economics. Lack of standards lock-in remains a major difference between the Pre-Web software (e.g. Microsoft) and Post-Web services (e.g. AOL) models. In the post-Web era, brand and volume become the key competitive weapons.

The implications for corporations are that increasingly, pockets of resource will be more centrally located to serve a more diverse set of customers. Computing and network "power" will increasingly concentrate within telco's, ISP's and outsourcers, making them exceedingly qualified managers of technology products and services (and notably a more important distribution channel).

Many have equated the rising momentum of services such as applications outsourcing to the return of the Timesharing model. There are major differences, however, particularly in the cost factors involved. Whereas processing power and telecommunications were the expensive resources in the days of timesharing, staff is the major element of cost in the network economy.

Increasingly, CIO's want to manage IT like their companies mange phone systems-- in utility-like fashion. The network services model is seen as the most viable path to this reality and will increasingly become a more common consideration in IT decision-making.

The simple message is strive to be the market leader in your industry for utilizing improved communications technology. Push communications suppliers hard to develop more competitive and mission critical service level guarantees. Importantly, communicate your strategy to your external partners as this will help smooth inevitable bumps in the road.

Design Flexibility into IT Infrastructures

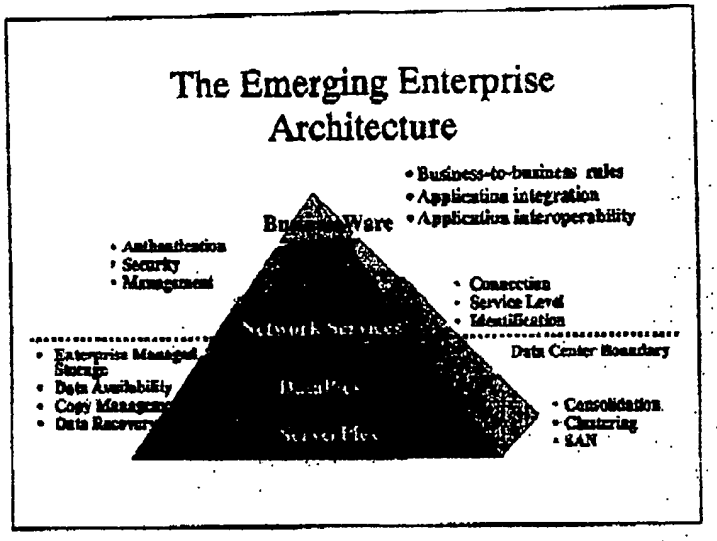
Time to market is becoming the single most important competitive differentiator for companies. By focusing on IT infrastructures that prioritize business flexibility, companies can add significant value by accelerating cycle times. Investigation and investment in technologies that foster a flexible infrastructure that enable an "any-to-any" topology are warranted in our view. Specifically, working toward an approach that allows any client, to access any application, on any server, to any data, independent of platform.

The following figure gives a framework for thinking about the architecture of the New World Data Center. It identifies five fundamental layers of an infrastructure that must fit into a seamless whole to meet the business and service level requirements of the organization; these include:

- **ServerPlex** – a set of tightly and loosely clustered servers.
- **DataPlex** – A storage infrastructure that is managed separately from servers and provides an any-to-any topology between data and applications.
- **Network & Client Services** – The infrastructure that connects applications to clients and other systems both inside and outside the organization.
- **MessageWare** –a set of services that provides communication between applications in a authenticated and secure manner.
- **BusinessWare** –A set of services that logically connects businesses together and provides a business process to business process infrastructure.

The balance of this position paper will drill down into each of these segments and provide specific information that will assist in the development of the framework.

Each discussion includes an overview of the state of the technology today, key issues and drivers of change and a view of the future capabilities in each layer.



ServerPlex

The bottom layer is the land of the servers, the workhorses of the data center. Today servers are organized as islands of computing, in a variety of different topologies. Applications run on a different platforms according to the "strategic fit" requirements of the application and organization.

- General applications run on "Open" Unix and NT servers, with NT applications being, in general closer to the workstation, and Unix systems being closer to the Network.
- A variety of specialized systems focus on specific application needs. Mainframes from IBM, Hitachi, Fujitsu/Amdahl, Tandem and Unisys meet the needs for high volume very reliable and rapid recovery systems – at a price. Systems like AS/400, and HP's 3000 series are mini-mainframes with similar characteristics. Novels NetWare is increasingly focused on network management.

Typically, one system holds the "data of record", and the others work off copies of this data. This data is moved between the islands of computing with a complex series of data transfers. Batch or offline processing is a standard way of dealing with re-synchronizing data across the set of systems.

Issues with Servers Today

There are numerous challenges with server deployment as organizations move towards the New World. Batch windows are under increasing stress. Data movement between servers is more complex. The LAN infrastructure is becoming increasingly a bottleneck as systems become larger. Managing the copies of data from an application design, application development and application deployment standpoint is a increasing problem, often manifesting itself in inter-department "disputes" about who owns the data of record.

Data warehousing systems find it difficult to move, load, synchronize, and clean data from an increasing variety of sources as user departments try to lower "time-to-decision".

While automation and operations of specialized platforms (e.g. mainframes) is generally good, the operation of open systems is less professional and automation rudimentary. Service level agreements are specific to applications and availability of open systems is patchy.

In addition, staffing levels are often high. Mainframe staffing tends to be specialized by function, while staffing on open systems is more general, and focused on platforms and groups of systems. As a result, fierce and unhelpful turf wars often break out over the merits of different platforms and vendors.

Management of resources across the data center tends to be rudimentary today. Spare resources on one system cannot usually be used by other systems, hence utilization of open servers is painfully low, with 30% utilization of servers viewed as a major achievement.

ServerPlex in the New World Data Center

As servers continue to get cheaper (40%/year price/performance improvements) and processor becoming more powerful (60% performance improvement/year) servers are becoming more specialized. The number of processors in systems is increasing with the advent of NUMA (Non-Uniform Memory Access). Partitioning systems so that multiple operating systems can run on large systems with flexible boundaries between them will become the norm over the next three years.

The most important technology innovations coming in the near term are the result of much improved high-speed communications between servers. Most Global 2000 installations will have four levels of inter-system communications, including:

- **LANs** – These will be upgraded to Gigabit Ethernet capability and will focus on communication between large numbers of users, systems, and low speed

peripherals such as printers. The bandwidth will increase significantly. However, these networks will not be sufficient to deal with the sustained data movements or the low latency requirements needed for typical application datasets. In general, Servers will decrease as a LAN management device as network vendors provide more specialized equipment to provide these functions.

- **SANs** – Storage Area Networks are rapidly coming of age and moving from a mainframe niche (ESCON) to Open systems (hubs and switches). The connection of all I/O is moving rapidly from a copper based medium to Fibre (which extends bandwidth and distance). Switches from Vendors such as Brocade, Ancor, McData, and Vixel provide the capability of implementing any-to-any topologies between Servers and I/O. As such, SANs are somewhat mis-named and perhaps should be referred to as ***System Area Networks.***

  SANs are more expensive than LANs per connection, but provide much better bandwidth and latency characteristics. While leading edge installations are implementing SANs today, most companies are waiting for vendors to provide packaged solutions. In general, SANs will be homogeneous (i.e. confined to a specific server environment) in the near future, with heterogeneous SANs several years away from general deployment as standards mature. The norm for customers will be to run "cloudlets" for the next several years.

  The exploitation of SAN will be through software that will provide the connectivity and systems independence of I/O. Leading contenders for providing the new "Systems NetWare" or SAN Operating System include Veritas and Legato, with Network Attached Storage vendors such as Auspex and NetApps also in the chase.

  The business case for SANs is impressive. Operational savings (from improved staff and equipment utilization) is significant, while improved availability and increased business flexibility (or time to market for new applications and application extensions) will provide an increasingly large share of the benefits as SANs mature.

- **High-Speed Interconnects** –Another important trend is to cluster systems. One major driver behind this will be the requirement for higher availability at much lower cost, as N→ 1 fail-over systems become possible (i.e. backing up multiple servers with a single failover system versus today's propensity to have multiple failover servers per individual application server. Another driver will be the requirement to manage workloads across a set of loosely clustered systems, known as administrative clustering. Similar to tightly clustered systems, loose clusters will require an operating system, file systems, and systems management functions to take on "Pan system"

capabilities. There will be an increasing requirement for very high bandwidth very low latency communication between nodes within the data center. This is likely to be carried across high-speed interconnects, which are emerging from companies such as GigaNet at very low prices. The likely emergence of the VIA standard from Intel as a cross platform initiative will accelerate the use of these networks by key ISVs such as DataBase vendors.

- **WAN Networks** –Servers will have less and less to do with Wide Area Networks as this work is taken over by specialized Network equipment and increasingly outsourced. However, in the area of disaster recovery, the usage of the increasing bandwidth between data center sites or outsourced sites will increase significantly. The "rule of five" should be applied where possible – the best networks are five feet apart, and the best disaster recovery sites five miles apart.

A key trend that will continue within the data center is the momentum to re-centralize systems either in site glass houses (or location centers). This trend will accelerate the implementation of SANs. Increasingly, Data centers will move from management by system to management by discipline, with specialization in operational automation, storage management, and network management across platforms. Data centers will continue to be populated by a variety of different platforms, and the fundamental organization of the data center will change from being servers surrounded by storage to storage surrounded by servers. Which leads to our discussion on storage.

Storage Today

Storage today is primarily directly attached to servers, with a fast growing centralized component based on shared storage between servers from companies like EMC and Hitachi. Management of storage is distributed among many disciplines, with an administrative arm here, a database administrator there, and a purchasing officer somewhere else.

Storage on open systems is bounded by the limitations of SCSI connections, both it terms of distance and in terms of pathing. Fibre has been installed for a long time on mainframe systems, and has greater than 90% penetration. Mainframe "SANs" suffer from the lack of interoperability and the lack of multi-node switching, as well as expensive components.

Storage Issues

In a recent survey ITcentrix found that the top three issues for

1. **Back-up windows** – the dramatic increase in size of the data on systems, and the lengthening of operation times for on-line systems have both conspired to make back-up windows a major problem. In a similar survey, the

number one cause of unavailability was found to be "batch overruns" extending back-up windows.

2. **Difficulty managing growth** – the most common statement from storage managers is "they tell me yesterday that storage is today for a project that was started a week ago." The infrastructure to handle the back-up of these systems, and the downstream work in managing copies and distribution of data throughout the data center are also under pressure. One of the frustrations is that there is a lot of data that is available but unusable, whether because of access constraints or because of bandwidth constraints.

3. **Performance management** – the majority of performance issues come down to data management, from allocation of the right type of storage to the placement of data sets. In specialized systems like mainframes, there are generally good tools to manage performance. In particular, the end-to-end architectures of these systems, which include hardware, operating system, and database, means that "probing" the system is much simpler. Open system storage managers are frustrated at the lack of performance management tools, and the transitory nature of storage performance problems. One of the fundamental problems is the lack of coordination between Unix and NT operating system developers, database developers, and hardware developers.

Storage is becoming cheaper and denser. But there are two important aspects of storage that is not improving – that is the data rate off the platter, and the access time to that data. These are constrained by the mechanical properties of spinning disks, and have not improved significantly over the last twenty years – disks rotated at roughly 3,000 RPM in the past, and are only at 12,000 today; a 4X improvement in twenty years. Considering capacity improvements have increased by approximately 10X in that same timeframe underscores the issue.

This leads to an increasing imbalance between the processor and storage technologies. This limitation is somewhat less important for traditional on-line systems that access small records but of much greater importance when trying to move large amounts of data between systems, i.e., to a data warehouse application.

The primary techniques that data centers have used to minimize these problems are to install a separate network for back-up, and to use caches (when the application is cache friendly), to improve the alternative pathing to data, and to provide parallel access to data.

The most fundamental issues with storage are not the cost. It is the cost to manage. As one storage manager said recently "I can afford to buy all the storage I need – what I can't afford is to manage it". Moving to professional storage management is an imperative for the data center of the New World.

The DataPlex of Tomorrow

The most important technologies for Storage are the same as for Servers – an improvement in the communication fabric between servers and I/O. Fibre breaks the distance limitations of SCSI. Although the standards are not yet complete, pragmatic fibre implementations are being implemented today. The development of Fibre and SANs is likely to follow that of the LAN in the early years, where the major problems where initially hardware compatibility, but where eventually a number of standards became de facto, and the software and hardware were able to complement each other.

Not all data will be connected to a SAN, and not all data connected to a SAN will be switchable. As always, there will be a mix of technologies in the data center. However, strategically thinking CIOs have already implemented a Fibre-first policy for storage, as this will protect investment in the development of the dataplex of the future.

In talking about Dataplexes, it is important to stress that there will be many Dataplexes in an installation. The break between them will be pragmatic – based on a combination between line of business, application type, and platform. The characteristics of a Dataplex are that the management of access to data is accomplished across the servers, not by the server of origin of the data. This allows enormous flexibility in the management of the data center as a whole.

Moreover, software enhancements to systems and data management are expected to allow dynamic allocation of storage, N→1 fail-over scenarios, and significantly better utilization of storage and server cycles. Some of the most important systems software to emerge will be the workload and dynamic workload management suites, which will bring to open systems what is currently available only in mainframe Sysplex environments.

This logical division between applications, servers, and data will allow center-wide policies to be implemented significantly more easily, and dramatic steps to be taken in the automation of data center processes and procedures. This in turn will lead to more available systems (operators are still the most unreliable component of a system) which are cheaper to run.

Users should expect that the appropriate server can be applied to the data, and servers and storage will increasingly be expected to be neutral to the specific file structures and formats. Users should focus on hardware and operating system vendors that understand the emerging imperatives on the data center of the future.

The Dataplex will allow central management of the typical backup, recovery, and hardware procedures. Again, specialized servers (or storage controllers) will offload the work from the application servers, and lead to greater specialization of servers to running applications, and away from managing networks.

The pressure of external users, and applications that are of increasing mission criticality brings some interesting implications to data recovery and disaster recovery. Although the probability of a long outage is very small, the impact can be enormous. Readers of the e-bay saga need go no further in understanding the dramatic impact outages can have on reputation and stock value.

Using similar constructs as described in previous sections of this report, the probability of an outage of greater than four weeks is assessed as only one per hundred years, yet its impact on the total expected loss is greater than all the outages of less than one hour combined!

As discussed in the section on Business Continuance and shown in figure xx titled "assessing the Value of Business Continuance", the disaster recovery imperative is to shift the # of Outages curve to the left (i.e. faster recovery times) thereby reducing the Expected business Loss.. As such, it the business imperative is focus on, measure and decrease the "time-to-recover for data loss". As a strategy this is much more effective (and easier) than lowering the number of incidents, many of which are outside the control of IT.

The traditional approach is either to outsource disaster recovery to the many specialist vendors offering such services, or to have a number of data centers in different areas of the country, each of which backs up of the other. Apart from cost, the major problem is that it is almost impossible to rigorously test a disaster scenario. The once-a-year test checks that tapes can be read, and often satisfies a Governmental requirement, but little more than that.

The availability of Fibre over distances of five miles or more means that users should re-evaluate their disaster recovery strategies. When the time to recover is taken into account, the business benefit (calculated as the expected data loss) of locating backup sites within Fibre distance is often significantly better. Of course care must be taken that the major causes of natural disaster (such as being in the same flood plain) are managed. The implementation of SANs over these longer distances is still relatively new, but again the pioneers are blazing a trail that the rest of us should be planning to follow within a year or two.

Specialist companies are now emerging that will provide data outsourcing, both for personal systems (companies like Atrieva) and for data centers (Companies like Storage Networks Inc.). The latter is leveraging local Fibre networks in major cities to provide data outsourcing services.

Networking Services

The importance of establishing internal networks within the data center has already been discussed above. The discussion centered on the importance of assessing the characteristics of the network that were best suited to the system and application characteristics.

In exactly the same way, external networks do and will continue to have to reflect the same requirements. Exciting new services such as IP value added networks (VANs) are available that can dramatically reduce network costs. Emerging are service level contracts that give guarantees on bandwidth, latency although leading customers still complain of inadequate commitments from vendors.

Networking & Client Services Today

Today's Network Services are either IP based or are rapidly moving to being IP based. The typical installation has a mixture of traditional leased lines and newer shared services.

Clients are dumb terminals and fat windows based desktops. These systems on the whole are within the corporation, though an increasing number of customers, suppliers, and business partners have access to the network. This will only increase as customers bring access and companies install capabilities like kiosks in the field.

Issues with Today's Networking

A major issue that users struggle with today is how take advantage of the emerging new services against a set of telecommunication suppliers that are intent on maintaining the revenues from their existing highly profitable traditional voice and leased line business. As such, the new services have profiles that make them attractive to start-up organizations, but lack some of the basic management and scaling features required by the global 2000 data centers.

For international customers, the provision of telecommunication services overseas is patchy to say the least. In Europe there are countries such as Scandinavia and the UK where the communication infrastructure has been liberalized, and communication services are at least the equivalent of the US. In other countries such as Germany, France, and Japan the government has moved far more slowly to deregulate and open up the telecommunication sector, and prices are high and services poor.

Future Networking Services

The world is rapidly moving towards a telecommunications model where data and data services are charged for, and voice comes for free. The bandwidth capability of new circuits is truly staggering, and the science of photonics goes ahead of all other computing technologies. At the same time that bandwidth is becoming universal, the speed of light and the latency of switches still brings significant constraints to providing low latency.

The importance of establishing internal networks (SANs and High-speed Interconnects) within the data center has already been discussed above. While these networks will mostly be managed separately from the LAN and WAN, the same principles apply whereby the emphasis is placed on the importance of assessing the

characteristics of the network that is best suited to the system and applications being supported.

In exactly the same way, external networks do and will continue to have to reflect the same requirements. Exciting new services such as IP VPN (Virtual Private Networks) are becoming available which can dramatically reduce network costs. The leading edge telecommunication companies are starting to provide robust service level contracts that give guarantees on bandwidth, latency and availability. Over the next few years these are expected to give service level characteristics that are equivalent to the best run internal networks, at significantly reduced costs.

Probably the most important change in Networking is the way in which the networking services will be delivered. The telecommunication companies are highly motivated to keep telecommunication spending increasing, and they will continue to emphasize services as both a differentiator and as a source of revenue. This is likely to be a win-win situation for users, as outsourcing of these types of services is an already proven model with voice services. Today very large voice services can be managed by a single person in a corporation. Everything, from the provision of phones to the setting up of user phone profiles is outsourced. Data services will almost certainly go the same way as voice services, and be effectively outsourced to the telecommunication providers.

CIOs should be driving to the same model for data networking services. The provision of network services will and should be increasingly outsourced, and the provision of "data-tone services" will be the norm. The implication of this is a continuance of the rise of importance of the telecommunications manager as pivotal to the service level performance of the installation.

Managing future clients is probably going to be one of the greatest headaches for the CIO. No longer can an organization dictate the standards that are going to be used. In general, clients will be thinner network access "devices", (such as palm pilots, cell phones, pagers and inexpensive PC's) and companies will have to react quickly to changes that their customers, suppliers, and partners will be driving. IT can dictate what kind of servers they have in the data center, but it cannot regulate what is going to be in the data centers of business partners. Interoperability and flexibility with the ability to support multiple standards are going to be the norm in the New World Data Center.

MessageWare & BusinessWare

The two other layers of the New World Architecture which are essential to the deployment of the externally facing applications of the future are the MessageWare and the BusinessWare layers.

Today's MessageWare and BusinessWare

While the world has moved on from the tape transfer of corporate data (except for seismic tapes), today's MessageWare standard is

primarily simple kinds of file transfer. Some organizations have started to implement MessageWare components such as IBMs MQ series with a guaranteed delivery architecture within the corporation. EDI systems have for some time provided similar services for companies within an industry.

Issues with Today's MessageWare and BusinessWare

Simply put, today's MessageWare offerings are not robust enough or secure enough for the rough and tumble of the Internet. The working systems are based on the Sabre protocol, in proprietary EDI systems, and within a single vendor's ERP system such as PeopleSoft.

A messaging infrastructure is required to be able to reliably send data between applications, both within a corporation and between corporations. It has to deal with the authentication of the applications that are communicating, and the security and auditability of the communication.

MessageWare of the Future

This technology is a vital component in the ability to move from a file transfer orientated system to a transaction based intersystem communication. Many vendors are claiming that they have working product. As the technologies emerge, users will need to select their vendor on a partnership basis as both partners iron out the true requirements of inter-company system to system communication.

The potential rewards are phenomenal. The original on-line system obviated the need for data entry specialists (e.g. punch card operators), drove data input to the source, improved business cycle times and improved data quality. In exactly the same way, MessageWare and BusinessWare will move the source data out to suppliers, customers, and partners directly. Companies who can succeed in providing a reliable (both from a systems and business point of view) infrastructure can expect enormous savings in people costs, IT quality and business cycle time reduction. For many companies, survival will depend on the development of such a capability.

BusinessWare of the Future

The other half of the services that will be required to reliably connect business will be frameworks and business models that logically connect businesses together and provide a business process to business process infrastructure.

For example, an individual is happy to buy a system from Dell Computer Corporation over the Internet in the way that Dell wants to do it. However, if GE wants to buy PCs and a million other items every year, it wants a common purchasing system for the whole corporation. Increasingly, buyers will expect suppliers to comply.

Internet purchasing systems are not yet up to this task. To resolve these issues requires agreeing to a common framework. To get reliable and fast implementation across company boundaries is almost certainly going to need the use of business objects and object based technologies.

This is one of the most important areas for partnering with vendors, and working with business constituents (including potential competitors). Solutions will initially be difficult, time-consuming, and very industry based. But the rewards to the companies that figure solve this problem first are going to be so compelling that the every CIO should set this capability as a key strategic objective, and constantly monitor progress toward the goal.

Conclusions

The New World Data Center – What's Different?

Following a path similar to the one suggested in this paper will likely result in IT vying for a larger share of corporate resources. Importantly, however, the New World Data Center will focus as a communication center rather than a pure data center. Additionally, it is likely the organization will serve more external than internal users and make greater investments in communication-specific than general-purpose IT.

A paradox of this approach is that although the benefits can be enormous, execution is not trivial. As such, implementers should expect to spend more on outside services than internal staff people. This makes setting standards even more crucial, especially when considering connections between customers, suppliers, & partners.

The bottom line is the New World Data Center will allow IT to be perceived as the major corporate facilitator of a network-centric vision - A vision that includes global connections, practical interconnectivity between divisions and the external world and an emphasis on e-business application enablement.

The New World Data Center encompasses all levels of IT and certain relevant levels of business management including:

- Senior corporate executives
- Senior IT executives
- Data Center Management
- IT Architects
- IT/IS/MIS Management
- Applications Development Managers
- Network Management
- Systems Integration and Outsourcing Professionals
- Line of Business Management

- Financial Management concerned with IT
- Liaisons to external partners

Consider that the typical Global 2000 data center of today has the following attributes.

- Multiple data and location centers – connected through a variety of private leased lines, emerging virtual private networks and the Internet for certain applications like email.
- Mostly isolated and private network traffic managed and controlled by the enterprise.
- Mature, legacy networks (with strong directory knowledge – e.g. SNA) interspersed with chaotic yet highly flexible, lower cost shared networks.
- An abundance of general purpose resources (e.g. servers, storage, OSes, etc.).
- Client devices are general purpose, standard and relatively stable.
- Systems management is server (as opposed to network) focused.
- Software elements are focused on solutions to specific business processes with some limited interconnection between enterprise divisions and lines of business.
- Applications are platform-specific and not well-integrated (e.g. mainly islands with spreading tentacles).
- Outsourcing efforts are mainly focused on broad categories (e.g. application maintenance).
- Services are tailored to solving unique problems but tend to be high cost, less replicable and difficult to customize.

The Global 2000 New World Data Center of the Future will have the following characteristics:

- Fewer but larger internally-managed data centers with increasingly outsourced location centers.
- Much more external network traffic on shared, public networks managed and controlled by Telcos/ISPs.
- Highly flexible, lower cost shared networks with much greater directory knowledge, security and guaranteed service levels - managed externally.

- Increasingly function-specific hardware and software resources (e.g. Storage-only networks).
- A plethora of non-standard, function-specific clients (e.g. cell phones, PDA's, Kiosks, etc.).
- End-to-end network management of enterprise service levels.
- Software built on strong interconnections within and increasingly outside the enterprise.
- Applications designed independent of storage and network topologies.
- An accelerated trend towards application outsourcing (e.g. outsourcing email and other business applications).
- Services are more network-based, highly customizable with much greater scale economies.

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